Bell Work
20/21-Jan-2015
New BW #2.2

Balance the following equation;

$\_Al + \_O_2 \rightarrow \_Al_2O_3$

How many moles **of Aluminum Oxide are produced from the combustion of 3 moles of Aluminum (think about the balanced equation and a molar ratio)**

Objective:

You will be able to set up a mole bridge using a balanced equation.

Stoichiometry

Stoichiometry

Balance the following equation:

$$4\ NH_3 + 5\ O_2 \rightarrow 6\ H_2O + 4\ NO$$

What is the ratio between ammonia and nitrogen monoxide? **4:4 or $\frac{4\text{mol } NH_3}{4\text{mol NO}}$**

What is the ratio between Nitrogen monoxide and oxygen? **4:5 or $\frac{4\text{ mol NO}}{5\text{ mol } O_2}$**

So for every 4 mol of NO you have 5 mol of O_2.

Stoichiometry

$4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

So many conversion factors exist:

4 mol NH_3/5 mol O_2, 6 mol H_2O/4 mol NH_3, etc

What if you had 2 mol of NO, how many moles of O_2 would you have?

$$2\text{mol NO} \times \frac{5\text{mol } O_2}{4\text{mol NO}} = 2.5\text{mol } O_2$$

What if you had 6 mol of H_2O, how many moles of O_2 would you have?

$$6\text{mol } H_2O \times \frac{5\text{mol } O_2}{6\text{mol } H_2O} = 5\text{mol } O_2$$

Stoichiometry

"Stoichiometry" refers to the relative quantities of moles. It also refers to calculations that make use of mole ratios.

Stoichiometry

$4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

Recall also that molar masses provide factors:

$$\frac{1 \text{ mol } NH_3}{17 \text{ g } NH_3} \qquad \frac{32 \text{ g } O_2}{1 \text{ mol } O_2}$$

Is $\frac{4 \text{ g } NH_3}{5 \text{ g } O_2}$ **a conversion factor?**

No!

The equation tells us moles not grams.

Stoichiometry Question 1a

Consider : $4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

How many moles of H_2O are produced if 0.176 mol of O_2 are used?

$$\#\ \text{mol } H_2O = 0.176\ \text{mol } O_2 \times \frac{6\ \text{mol } H_2O}{5\ \text{mol } O_2} =$$

0.21 mol H_2O

Notice: A correctly balanced equation is essential to get the right answer

Stoichiometry questions (1b)

Consider : $4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

How many moles of NO are produced in the reaction if 17 mol of H_2O are also produced?

$$\#\ \text{mol NO} = 17\ \text{mol } H_2O \times \frac{4\ \text{mol NO}}{6\ \text{mol } H_2O} =$$

11.33 mol NO

Notice: A correctly balanced equation is essential to get the right answer!

Recall

What is essential to perform stiochiometry?

Stoichiometry questions 1c

Consider : $4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

How many moles of NH_3 are needed in the rxn if 0.5 mol of H_2O are also produced?

$$\#\ \text{mol } NH_3 = 0.5\ \text{mol } H_2O \times \frac{4\ \text{mol } NH_3}{6\ \text{mol } H_2O}$$

= 0.33 mol NH_3

This is what anhydrous ammonia will do to your skin

The "Mole Bridge"

The Mole Bridge is used to convert from one type of compound to another via their molar ratio based on a *Balanced* equation.

You have just converted from one type of compound to another in moles.

Now what if you wanted to go from moles of one compound to grams of another?

The "Mole Bridge"

Now what if you wanted to go from moles of one compound to grams of another?

Moles of A → grams of B

$$\text{mol A} \times \frac{\text{mol B}}{\text{mol A}} \times \frac{\text{Molar Mass B}}{1\ \text{mol B}} = \text{grams B}$$

The Mole Bridge

Your Turn

Consider : $4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

How many grams of H_2O are produced if 1.9 mol of NH_3 are combined with excess oxygen?

$$\#\ g\ H_2O = 1.9\ \text{mol } NH_3 \times \frac{6\ \text{mol } H_2O}{4\ \text{mol } NH_3} \times \frac{18\ g\ H_2O}{1\ \text{mol } H_2O} =$$

51 g H_2O

Your Turn

Consider : $4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

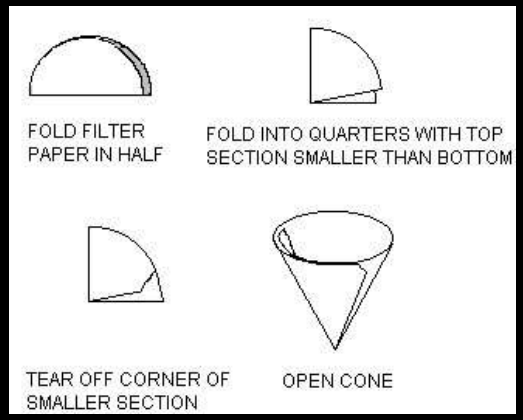
How many grams of O_2 are required to produce 0.3 mol of H_2O?

$$\#\ g\ O_2 = 0.3\ \text{mol } H_2O \times \frac{5\ \text{mol } O_2}{6\ \text{mol } H_2O} \times \frac{32\ g\ O_2}{1\ \text{mol } O_2} = \mathbf{8\ g\ O_2}$$

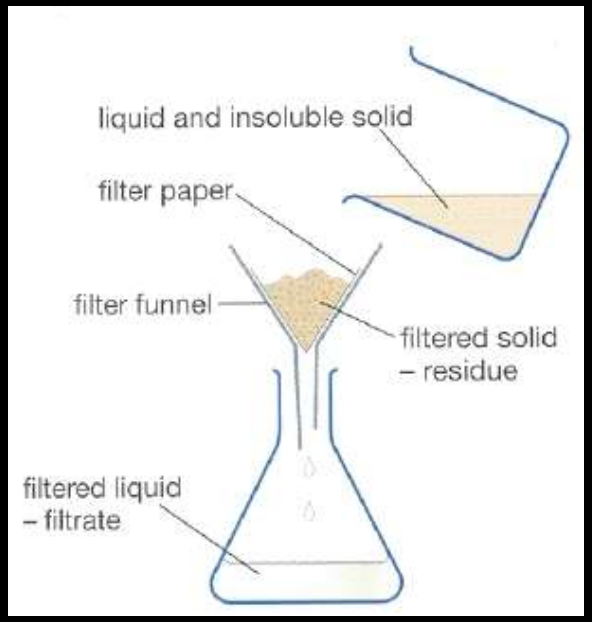
Fe/ $CuSO_4$: Day 1

Safety: $CuSO_4$ ($CuSO_4 \cdot 5H_2O$)is mildly toxic

Try not to decant any of the solid out of the rxn beaker.



Label and then weigh the filter paper before filtering



Before You Go

Write out the steps for completing stiochiometery.

HW:

Read p. 233-237

Work out all examples and complete #28-32

Bell Work
22-Jan-2015

If lead (II) nitrate reacts with potassium iodide what are the two products?

Write out a balanced equation

What type of reaction is this?

If you have 2moles of lead (II) nitrate how many grams of potassium iodide would you need for a <u>complete</u> rxn?

Objective:

To examine theoretical and actual yields in the lab.

Percent Yield

Rxns rarely produce the predicted amount of product from the masses of reactants in the rxn.

$1Fe(s) + 1CuSO_4(aq) \rightarrow 1FeSO_4(aq) + 1Cu\ (s)$

An example of this is the rxn of $CuSO_4$ with Fe. Normally we expect a 1 mol yield of Cu for every mol of Fe reacted. This does not always happen.

Percent yield

If you react 55.8 g of Fe to make Cu, the amount of Cu expected is 1 mol of Cu or 63.5 g of Cu.

$1Fe(s) + 1CuSO_4(aq) \rightarrow 1FeSO_4(aq) + 1Cu(s)$

Sadly the amount you get will probably be < 63.5g say, 50 g of Cu. The problem is a competing rxn or complexing of a Cu ion that happens.

Percent Yield

The Cu^{2+} participating in this "complexing" will not be able to make Cu. The reaction will not yield 100% of the expected Cu.

The amount of Cu produced, ~50 g is only 78.7% and not 100 % of the expected 63.5 g.

Percent yield = 100 x $\frac{\text{50 g Cu actual}}{\text{63.5 g Cu predicted}}$ → 78.8%

Percent Yield

$$\text{Percent yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$$

What is the percent yield for a rxn if you predicted the formation of 21 g of C_6H_{12} and actually recovered only 3.8 g?

Percent yield = 100 x $\frac{\text{3.8 g } C_6H_{12} \text{ actual}}{\text{21 g } C_6H_{12} \text{ predicted}}$ → 18%

Fe/ $CuSO_4$: Day 2

Dispose of solid waste in labeled container in hood

Then finish post lab for homework.

Bell Work
23-Jan-2015

What is stoichiometry in your own words?

Come up with a general formula to convert from grams of one substance to grams of another

Objective – you will be comfortable converting from grams of one substance to grams of another in a balance equation

Moving along the stoichiometry path

Given: $4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

a) **How many moles of H_2O can be made using 0.5 mol NH_3?**

b) **What mass of NH_3 is needed to make 1.5 mol NO?**

c) **How many grams of NO can be made from 120 g of NH_3?**

Converting grams ←→ grams

Notice that we cannot directly convert from grams of one compound to grams of another. Instead we have to go through moles.

Many stoichiometry problems follow a pattern:

gram(A) ↔ mol(A) ↔ mol(B) ↔ gram(B)

grams of A → grams of B

Converting grams ↔ grams

Many stoichiometry problems follow a pattern:

gram(A) ↔ mol(A) ↔ mol(B) ↔ gram(B)

grams of A → grams of B

$$\text{gram A} \times \frac{1\ \text{mol A}}{\text{MM A}} \times \frac{\text{mol B}}{\text{mol A}} \times \frac{\text{MM B}}{1\ \text{mol B}} = \text{grams B}$$

Grams A to Moles A

Mole Bridge

Moles B to Grams B

Your Turn… You need to think a little harder!

Consider : $4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

How many grams of NO is produced if 12g of O_2 is combined with excess ammonia?

\# g NO=

$$12 \text{ g } O_2 \times \frac{1 \text{ mol } O_2}{32 \text{ g } O_2} \times \frac{4 \text{ mol NO}}{5 \text{ mol } O_2} \times \frac{30 \text{ g NO}}{1 \text{ mol NO}}$$

$$= \mathbf{9.0 \text{ g NO}}$$

Converting grams to grams

grams(A) $\leftrightarrow$ moles(A) $\leftrightarrow$ moles(B) $\leftrightarrow$ grams(B)
We can start anywhere along this path

So, for the rxn $2H_2 + O_2 \rightarrow 2H_2O$ what is the path we would take for the following

Given 2 mol H_2O, calculate grams H_2O?

Moles O_2 required for 36 g H_2?

Grams of H_2O produced from 6g O_2?

36g **9moles** **6.75g**

Answers

$$4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$$

a)

$$\#\ \text{mol } H_2O = 0.5\ \text{mol } NH_3 \times \frac{6\ \text{mol } H_2O}{4\ \text{mol } NH_3} = 0.75\ \text{mol } H_2O$$

b)

$$\#\ \text{g } NH_3 = 1.5\ \text{mol NO} \times \frac{4\ \text{mol } NH_3}{4\ \text{mol NO}} \times \frac{17.04\ \text{g } NH_3}{1\ \text{mol } NH_3} = 25.6\ \text{g } NH_3$$

c)

$$\#\ \text{g NO} = 120\ \text{g } NH_3 \times \frac{1\ \text{mol } NH_3}{17.04\ \text{g } NH_3} \times \frac{4\ \text{mol NO}}{4\ \text{mol } NH_3} \times \frac{30.01\ \text{g NO}}{1\ \text{mol NO}}$$

$$= 211\ \text{g NO}$$

Small Group

Stiochiometry Practice #2,

You will complete Stiochiometry Practice #2 in a small group.

As a team, work out each problem on white boards, showing all work.

More Stoichiometry Questions

1. **$2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$**

a) What mass of O_2 will react with 400 g C_4H_{10}?

b) How many moles of water are formed in a)?

a)1434g b)34.5moles

2. **$3\ HCl + Al(OH)_3 \rightarrow 3\ H_2O + AlCl_3$**

How many grams of aluminum hydroxide will react with 5.3 moles of HCl? 137.8g

3. **$Ca(ClO_3)_2 \rightarrow CaCl_2 + 3\ O_2$**

What mass of O_2 results from the decomposition of 1.00 kg of calcium chlorate? 466g

Continued

4. $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$. a) 3.09g b) 28.3g

A) How many moles of carbon monoxide are required to react with 163.0 g of iron(III) oxide?

B) How many grams of CO_2 are produced from a reaction that also produces 23.9 grams of Fe?

5. $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$

A) How many moles of copper(II) nitrate can be prepared from 17.0 moles of Cu?

B) How many grams of copper(II) nitrate can be prepared using 3.8 moles of HNO_3?

C) What mass of water results from the reaction of 8.50 kg of copper metal?

HW 23.Jan.2015

Finish Stiochiometry Practice #2

Bell Work
26-Jan-2015

$Cu + AgNO_3 \rightarrow$ _?_ + _?_ (use Cu^{2+})

(1) Balance the equation.

(2) How many grams of silver are formed from 2.0 grams of copper?

(3) How many grams of silver are formed from 2.0 grams of silver nitrate?

EQ: Week four into the new semester…how have you been doing in your goal to do better in this course this semester compared to last? What is one thing you can still improve upon to continue to improve?

Objective:

Use an online program to practice finding limiting reagents

http://phet.colorado.edu/en/simulation/reactants-products-and-leftovers

Before you go…

Write four (4) sentences dealing with how you will use stoichiometry to solve chemical calculations and the steps involved with stiochiometry in your own word W/O looking at your notes.

HW

Finish Stiochiometry Practice #2

Bell Work
27-Jan-2015

Name the following compounds:

$(NH_4)_2Cr_2O_7$ **PCl_5** **$Mo(PO_4)_2$**

What do the coeficients infront of species in a balance equation represent?

Agenda

Limiting Reagent introduction/ notes

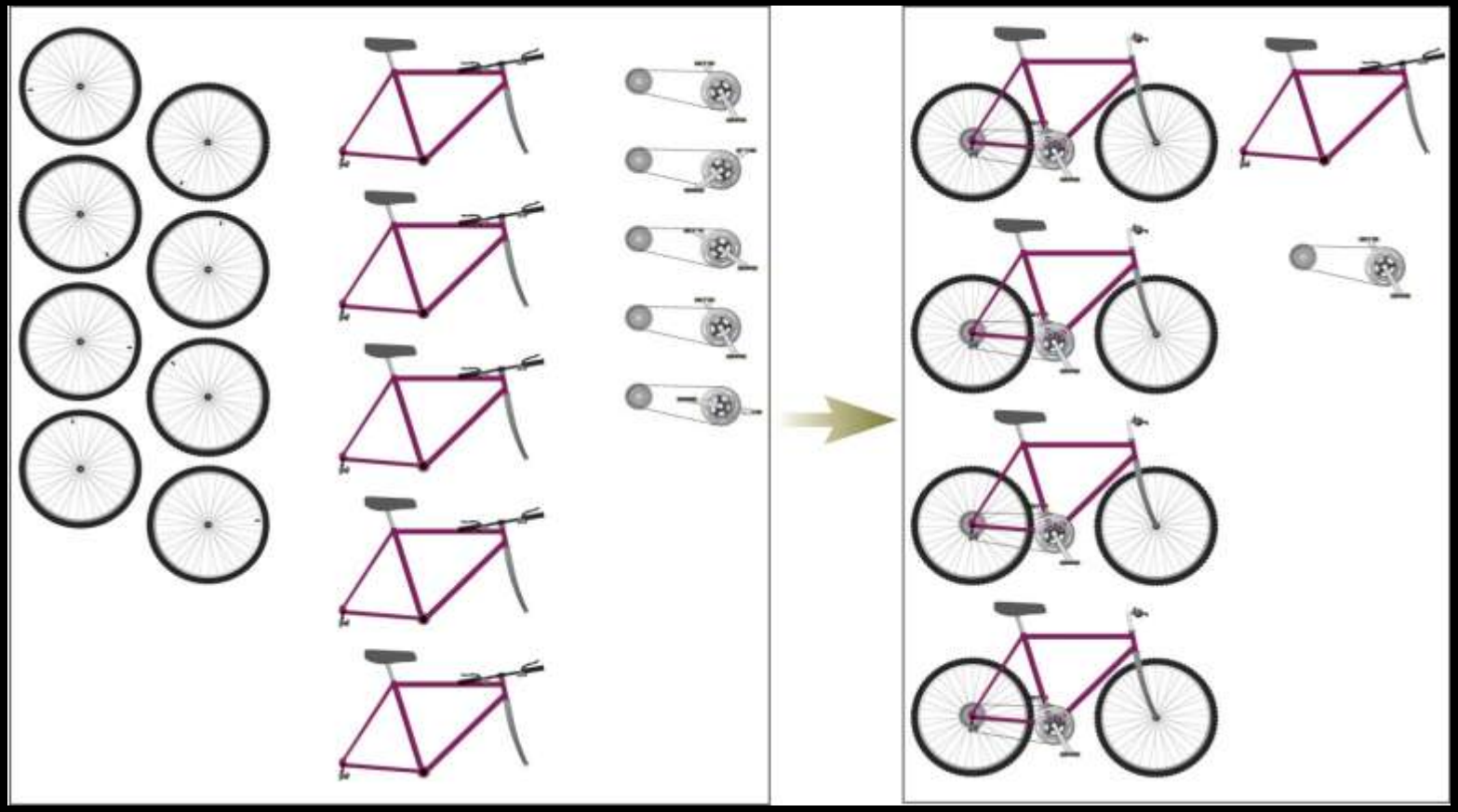
Practice ~~and pre-lab~~

Objective:

You understand that some reactants run out before others and will be able to determine the limiting reagent in a reaction

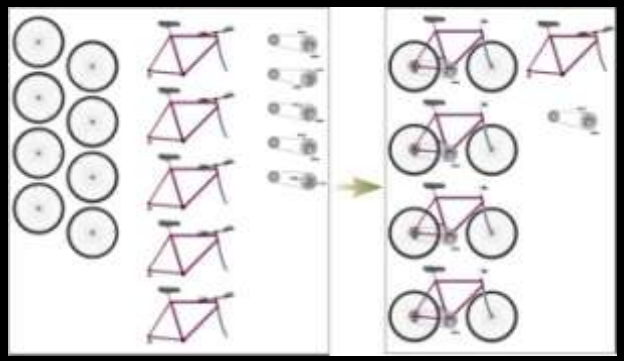
Limiting Reagent

The reactant that is completely consumed by the reaction.



Limiting Reagent

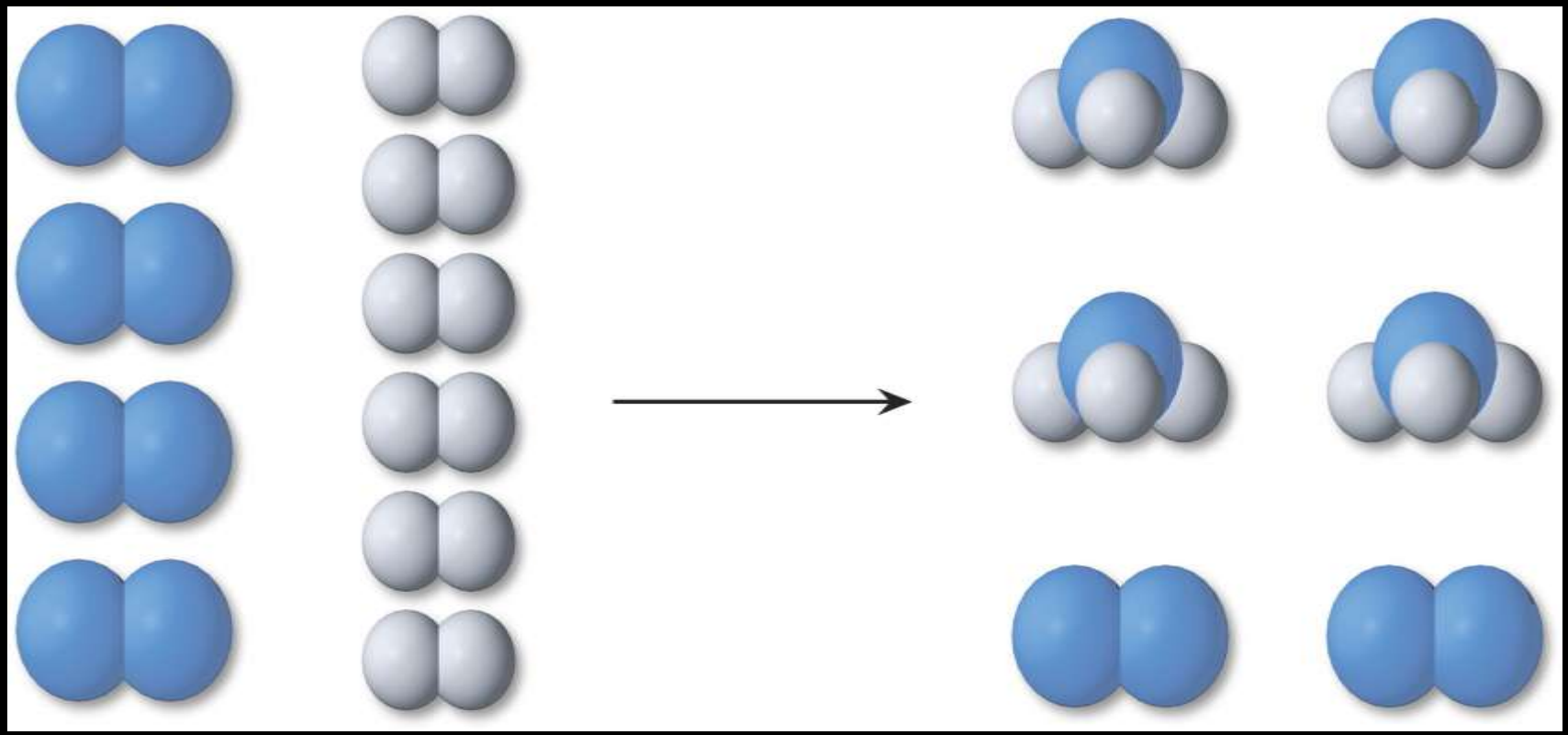
The reactant that is completely consumed by the reaction



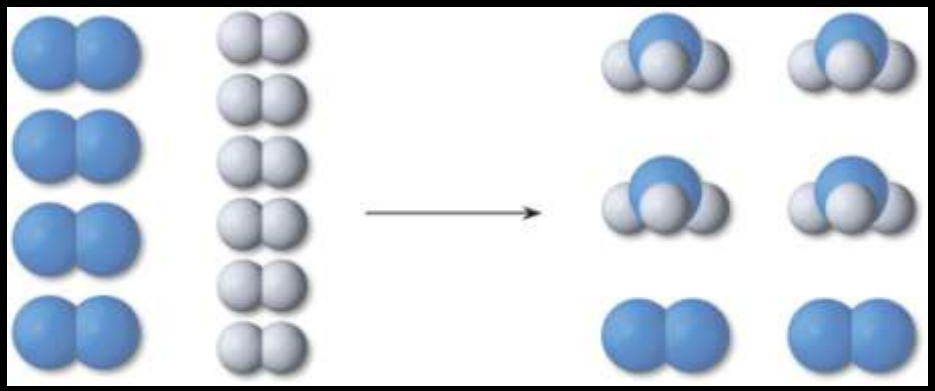
The number of bicycles that can be assembled is limited by whichever part runs out first. In the inventory shown in this figure, wheels are that part.

Limiting Reagent

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$



Limiting Reagent



A molecular view of a Limiting reactant situation for the ammonia synthesis. To make 4 molecules of NH_3 requires 2 molecules of N_2 & 6 molecules of H_2. If we start with 4 molecules of N_2 and 6 molecules of H_2, H_2 is the limiting reactant.

Limiting Reagent

$$4KO_{2(s)} + 2H_2O_{(l)} \rightarrow 4KOH_{(s)} + 3O_{2(g)}$$

a. How many moles of O_2 can be produced from 0.15 mol KO_2 and 0.10 mol H_2O?

b. Determine the limiting reactant.

$$4KO_2(s) + 2H_2O(l) \rightarrow 4KOH(s) + 3O_2(g)$$

0.15 mol **0.10 mol** **? moles**

Limiting Reagent

b. Determine the limiting reactant.

$$4KO_2(s) + 2H_2O(l) \rightarrow 4KOH(s) + 3O_2(g)$$

0.15 mol **0.10 mol** **? moles**

Based on KO_2 :

$$0.15 \text{ mol } \cancel{KO_2} \times \frac{3 \text{mol } O_2}{4 \text{mol } \cancel{KO_2}} = 0.1125 \text{ mol } O_2$$

Limiting Reagent

b. Determine the limiting reactant.

$$4KO_2(s) + 2H_2O(l) \rightarrow 4KOH(s) + 3O_2(g)$$

0.15 mol **0.10 mol** **? moles**

Based on **H_2O:**

$$0.10 \text{ mol } H_2O \times \frac{3 \text{mol } O_2}{2 \text{mol } H_2O} = 0.15 \text{ mol } O_2$$

Limiting Reagent

b. Determine the limiting reactant.

$$4KO_2(s) + 2H_2O(l) \rightarrow 4KOH(s) + 3O_2(g)$$

0.15 mol **0.10 mol** **? moles**

Based on KO_2 : **= 0.1125 mol O_2**

Based on H_2O: **= 0.15 mol O_2**

KO_2 is the limiting reagent because it limited the amount of O_2 that could be produced. H_2O is the excess reagent.

Limiting Reagent

So to find limiting reagents carry out the stiochiometry for each of your reactants that you are give a quantity for.

The reactant that gives you the smallest value of product is your limiting reagent.

Use this reactant for all calculations

Practice questions

1. **$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$**
   If 25 g of aluminum was added to 90 g of HCl, what mass of H_2 will be produced?

2. **$N_2 + 3H_2 \rightarrow 2NH_3$: If you have 20 g of N_2 and 5.0 g of H_2, which is the limiting reagent?**

Practice questions

2. **$N_2 + 3H_2 \rightarrow 2NH_3$: If you have 20 g of N_2 and 5.0 g of H_2, which is the limiting reagent?**

3. **What mass of aluminum oxide is formed when 10.0 g of Al is burned in 20.0 g of O_2?**

Bell Work
28-Jan-2015

Candle wax reacts with oxygen to form water and carbon dioxide through the following chemical reaction:

$$\_C_{40}H_{82} + \_0_2 \rightarrow \_CO_2 + \_H_20$$

1. **Balance the equation**
2. **If there is approximately 1.1 g of oxygen in the container and the mass of the candle is 0.8 g what is the limiting reagent for this reaction (MM $C_{40}H_{82}$ = 562 g/mol)?**

Limiting Reagent Practice #2

Credit given only when all work is shown.

Must complete problems #1-6 on p.2 and ONE of the problems from p.3 in order to go to the science fair

I have provided the answers to each problem. Use them to **check** your work only

Bell Work
29.Jan.2015

25 student walk into a room where the teacher hands out 13 extra credit slips. If the rxn is

Stnd + ExtrC = ☺,

- What is the limiting reagent?
- What is the non-limiting reagent?
- How much non-limiting reagent is left over?

Objective

You will see limiting reagents in the lab

Limiting Reagent Pre lab

You will make a full pre-lab, you may use the table in the handout for recording data

Limiting Reagent Lab

You will work in groups of at your lab bench

The molar ratio will be:

4people
6rxns

Or **4people**
6balloons

Limiting Reagent Lab

Limiting reagents are so easy! I figured it out, even after pooping my pants

Person A mass out of $NaHCO_3$

Person B help person D Clean and dry all test tubes, **do not over use paper towels!**

Person C will use a 10mL graduated cylinder to obtain the $HC_2H_3O_2$

Before you go

List the steps you would use to determine how to find the amount of the non-limiting reagent that is left over from a reaction.